PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing: 16 December 1999 (16.12.99)	
International application No.: PCT/IB99/01001	Applicant's or agent's file reference: 138032
International filing date: 03 June 1999 (03.06.99)	Priority date: 11 June 1998 (11.06.98)
Applicant: SEIBERLE, Hubert et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International preliminary Examining Authority on:

13 October 1999 (13.10.99)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer:

J. Zahra

Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

LIEBETANZ, Michael
Isler & Pedrazzini AG
P.O. Box 6940
CH-8023 Zurich
SUISSE

Date of mailing (day/month/year) 04 October 2000 (04.10.00)	
Applicant's or agent's file reference 138032	**IMPORTANT NOTIFICATION**
International application No. PCT/IB99/01001	**International filing date** (day/month/year) 03 June 1999 (03.06.99)

1. The following indications appeared on record concerning:

[X] the applicant [ ] the inventor [ ] the agent [ ] the common representative

Name and Address	State of Nationality	State of Residence
ROLIC AG Innere Güterstrasse CH-6301 Zug Switzerland	CH	CH
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[ ] the person [ ] the name [X] the address [ ] the nationality [ ] the residence

Name and Address	State of Nationality	State of Residence
ROLIC AG Chamerstrasse 50 CH-6301 Zug Switzerland	CH	CH
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

3. Further observations, if necessary:
Please note the address of the newly appointed agent (addressee).

4. A copy of this notification has been sent to:

[X] the receiving Office
[ ] the International Searching Authority
[ ] the International Preliminary Examining Authority
[ ] the designated Offices concerned
[X] the elected Offices concerned
[ ] other:

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Jocelyne Rey-Millet
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

LIEBETANZ, Michael
Isler & Pedrazzini AG
P.O. Box 6940
CH-8023 Zurich
SUISSE

Date of mailing (day/month/year) 08 January 2001 (08.01.01)	
Applicant's or agent's file reference 138032	**IMPORTANT NOTIFICATION**
International application No. PCT/IB99/01001	**International filing date** (day/month/year) 03 June 1999 (03.06.99)

1. The following indications appeared on record concerning:

[X] the applicant [X] the inventor [ ] the agent [ ] the common representative

Name and Address	State of Nationality	State of Residence
SCHADT, Martin	CH	CH
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[ ] the person [ ] the name [ ] the address [ ] the nationality [ ] the residence

Name and Address	State of Nationality	State of Residence
SCHADT, Martin	CH	CH
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

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3. Further observations, if necessary:
The person in Box II is applicant / Inventor for the US only.

4. A copy of this notification has been sent to:

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[ ] the International Searching Authority
[X] the International Preliminary Examining Authority
[ ] the designated Offices concerned
[X] the elected Offices concerned
[ ] other:

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Lazar Joseph Panakal
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
138032		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IB99/01001	03/06/1999	11/06/1998
International Patent Classification (IPC) or national classification and IPC G02F1/1337		
Applicant ROLIC AG et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
13/10/1999	15.03.2000
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Petitpierre, O Telephone No. +49 89 2399 2748

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IB99/01001

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-13 as originally filed

Claims, No.:

1-29 as originally filed

2. The amendments have resulted in the cancellation of:

☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they hav been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims 1-29
	No:	Claims
Inventive step (IS)	Yes:	Claims 1-29
	No:	Claims
Industrial applicability (IA)	Yes:	Claims 1-29
	No:	Claims

2. Citations and explanations

see separate sheet

Part V: Novelty and inventive step (Art. 33 PCT)

1 The problem addressed by the present application is the provision of a polymerizable mixture comprising a photo-orientable crosslinkable liquid crystal polymer precursor, as recited in claim 1.

2 This problem is solved by adding a photo-orientable additive to a crosslinkable liquid crystal polymer. This additive may be a monomer, an oligomer, or a polymer.

3 This solution is not disclosed or suggested by any of the documents cited in the International Search Report.

3.1 US-A-5 602 661 and EP-A-0 445 629 disclose optical devices comprising separate layers for the photo-orientable additive, here in the form of a photo-orientable monomer which is polymerized after photo-orientation, and for the cross-linkable liquid crystal polymer.

3.2 US-A-5 539 074, DE-A-4 420 585, the article by V. G. Chigrinov et al., and the three articles by M.Schadt et al. disclose a photo-orientable and photo-crosslinkable orientation layer which is subsequently used to align a liquid crystal layer.

3.3 The remaining document, namely, DE-A-196 00 033, discloses the use of a liquid crystalline polymer as orientation layer for FLCs.

4 Claims 2 to 16 relate to specific embodiments of the mixture of claim 1.

Claims 17 to 19 relate to a film precursor, respectively, a substrate and an optical component which are prepared from the mixture of claims 1 to 16. Claims 20 to 25 relate to specific embodiments of the optical component of claim 20.

Claim 26 relates to a method of preparing the mixture of claim 1. Claims 27 and 28 relate to particular embodiments of the method of claim 26. Finally, claim 29 relates to an optical component obtained by the method of claims 26 to 28.

PATENT COOPERATION TREA

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
138032		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/IB 99/ 01001	03/06/1999	11/06/1998
Applicant		
ROLIC AG et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

[ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

[ ] contained in the international application in written form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readble form.

[ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. --

[ ] as suggested by the applicant.

[ ] because the applicant failed to suggest a figure.

[ ] because this figure better characterizes the invention.

[ ] None of the figures.

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International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: SEIBERLE, Hubert [DE/DE]; Bodenseestrasse 1, D–79576 Weil am Rhein (DE).

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(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: OPTICAL COMPONENT, ORIENTATION LAYER, AND LAYERABLE POLYMERISABLE MIXTURE

(57) Abstract

In place of separately applied LPP and LCP layers to make an optical component, 7 parts by weight of LCP crosslinkable–diacrylate monomers are mixed with 3 parts of poly(benzopyranoxycarbonyl)ethylene, which itself is linearly photopolymerisable, applied to a substrate, heated to above their isotropic transition temperature, exposed to polarised light, cooled, purged with nitrogen and exposed to light, to make optical components such as retarders or liquid crystal displays.

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OPTICAL COMPONENT, ORIENTATION LAYER, AND LAYERABLE POLYMERISABLE MIXTURE

This invention relates to a polymerisable mixture which can be applied as a layer, to an orientation layer of the mixture, and to an optical component (such as a retarder or a liquid crystal display) having a layer of which the mixture is a precursor.

Anisotropic transparent or coloured cross-linked polymer layers with three-dimensional orientation of the optical axis, either uniform or preset at individual places, are of great interest in many sectors of display technology, integrated optics etc.

For some years, substances having this property in principle have become known, namely certain cross-linkable liquid crystalline diacrylates and diepoxides. Before cross-linking, these substances can be orientated in the liquid crystalline phase in sandwich cells consisting, for example, of glass plates having an interposed monomer layer with the aid of conventional orientating layers on the two glass plate surfaces or under the influence of external fields, e.g. strong magnetic or electric fields, and in a second phase can be photo-cross linked in the cells such that the wall forces acting on the two sides of the monomer layer, or the applied fields, preserve the preset orientation during the cross-linking process.

Cross-linked liquid crystalline monomers or oligomers or polymers are also referred to as LCPs (liquid crystal polymers) in the following text.

There have also become known methods which permit the production of orientation layers with locally variable orientating properties.

U.S. Patent No. 4,974,941 (Gibbons *et al.*) describes a process wherein a preferred direction is induced in response to exposure with linearly polarised light of an appropriate wavelength by the cis-trans-isomerisation of dyes. Liquid crystals in contact with a surface thus exposed are oriented in accordance with this preferred direction. This orientation process is reversible – i.e., by further exposure of the layer to light of a second polarisation direction the orientation direction can be rotated again.

In the case of the photostructurable orientation layers described in U.S. Patent No. 5,389,689 (Chigrinov *et al.*), an irreversible anisotropic polymer network is used. During the exposure to linearly polarised light, anisotropic orienting properties are induced in a photo-polymerisable layer and at the same time a polymer network is built up. Such linear photo-polymerised polymer networks (LPP), also known as photo-oriented polymer networks (PPN), are of use wherever stable, structured or unstructured liquid crystal orientation layers are required.

Layer structures comprising an anisotropic film of LCPs in contact with an orientating layer of a linear photo-polymerised polymer network (LPP) are described in U.S. Patent No. 5,602,661 (Schadt *et al.*). The manufacture of these layer structures is effected by orientation of the liquid crystal by interaction with the LPP layer and fixing the orientation in a subsequent cross-linking step. With this technique, it is even possible to manufacture multi-layer structures consisting of several oriented liquid crystal polymer layers, as is shown e.g. in European Application No. 0 689 084 (Schadt *et al.*).

As is well known, in addition to an azimuthal alignment, a tilt angle, i.e. an inclination of the optical axis of the liquid crystal layer relative to the plane of the layer, is often necessary. This can be achieved by an LPP orientation layer having a tilt angle on the surface, disclosed e.g. in European Application No. 0 756 193 (Schadt *et al.*).

To sum up, it can be said that LCP layers, usually in combination with orientation layers, are the basis of a large number of optical components like retarders, optical filters, polarizer etc. Layer structures of the type mentioned above with locally varying optical axes can also be used as a safeguard against counterfeiting and copying, as disclosed for example by European Application No. 0 689 065 (Schadt *et al.*).

Furthermore, it is well known to the artisan and understood in the present context that orientation layers are not only used for producing LCP components but also for aligning liquid crystals in liquid crystal displays, light valves etc.

The present invention provides and opens up new possibilities both for optical components, particularly of the aforementioned kind, and for liquid crystal orientation layers.

According to the invention, a polymerisable mixture comprises

(i) a liquid crystal monomer or pre-polymer having cross-linkable groups; and

(ii) a photo-orientable monomer or oligomer or polymer.

Despite the distinct functions of the participating molecules, it has been surprisingly discovered that these mixtures are capable of being both oriented and cross-linked into a liquid crystal polymer. These mixtures are hence usable on the one hand as anisotropic layers in optical components or on the other hand, normally applied more thinly, as orientation layers.

This leads to various advantages hitherto unavailable.

In the case of an anisotropic layer for an optical component, only one layer need be applied instead of the hitherto necessary two, thus reducing the number of processing steps.

In the case of an orientation layer, the orientation proceeds not only at the surface of the layer but can proceed throughout its depth.

It is no longer necessary to apply and appropriately (e.g. imagewise) expose or irradiate an e.g. patterned orientation layer before the LCP layer is applied, in other words the entire layer-applying stage can be completed before the exposure/irradiation stage. These stages can be performed quite independently and even at separate locations. This is an important benefit for security purposes, where a secret alignment pattern is to be imposed on an LPP layer; the manufacturer who applies the LPP layer does not (as hitherto) need to be given the secret pattern, which improves the safeguards against counterfeiting.

Varying the types and proportions of the various chemical components of the mixtures according to the invention is a useful tool for influencing properties such as viscosity and coatability of the mixtures; for example, an unacceptable coalescence into globules of an applied layer of such a mixture can be inhibited by increasing its viscosity.

By "photo-orientable" is meant that the substance (ii) is capable of developing a preferred direction when irradiated with linearly polarised light and thus inducing an alignment of liquid crystals.

It is understood that substance (i) may also be an LCP mixture, i.e. may contain two or more different liquid crystal molecule types. Equally, substance (ii) may be a mixture of photo-orientable molecules.

Assuming that the cross-linkable liquid crystal substance (i) is present in an amount of 100 parts, the photo-orientable substance (ii) preferably is present in an amount of at least 0.1 part, more preferably of at least 1 part, most preferably of at least 10 parts.

A preferred photo-orientable substance (ii) comprises molecules showing a cis-trans-isomerism, particularly azo dyes.

Another preferred photo-orientable substance (ii) comprises a linearly photo-polymerisable monomer or oligomer or polymer.

Depending on the intended application, the cross-linkable liquid crystal substance (i) may have a nematic phase or cholesteric phase or a ferroelectric phase respectively.

The substance(s) (i) is/are preferably acrylate or diacrylate.

In a preferred embodiment of the invention, the mixture further comprises chiral molecules.

In another preferred embodiment, the mixture further comprises dye molecules.

In another preferred embodiment, the mixture further comprises dichroic molecules.

In another preferred embodiment, the mixture further comprises fluorescent molecules.

A presensitised film precursor according to the invention comprises a substrate (such as a plastic film) carrying a layer (e.g. 0.1 to 5 microns thick) of a mixture as set forth above.

Such a precursor can be manufactured in industrial-sized rolls and transported to the end user (in the dark). The applied layer should be able to withstand the rigours of transport, especially if protected by a peel-off layer.

A substrate carrying a layer of a mixture according to the invention, for many applications, should be conductive under the layer.

An optical component according the invention comprises a layer of a mixture as set forth above, in which the liquid crystal monomer or pre-polymer is at least partly polymerised. Such a layer usually will be optically anisotropic.

Preferably, the layer has a preferred orientation direction or locally varying preferred orientation directions, which may be at an angle to the plane of the substrate, in other words with a tilt angle.

The thickness of the layer will depend on the use. Thus, for an optical component intended to be used in its own right, such as for instance a retarder, an optical filter, a polarizer or a polarised light emitter, a relatively thick layer, e.g. 0.3 to 5 μm, is preferred. For a layer which is intended to act as an orientation layer without significant inherent optical properties, a thinner coating such as 0.01 to 1 μm is preferred. Although photo-orientable compounds, particularly LPP compounds, can be used by themselves as orientation layers, the LCP compounds may advantageously confer networking forces retaining the preferred direction in the photo-orientable compounds.

A method according to the invention of making an at least partly polymerised, optically anisotropic layer of a mixture as set forth above comprises exposing the mixture (preferably in its isotropic phase, e.g. by warming it) to linearly polarised light (optionally in different orientations in different parts of the layer, for example in

imagewise, patternwise and pixellated arrangement) while maintaining such conditions that the polymerisation or cross-linking of substance (i) is essentially inhibited, whereby at least some of the molecules of the substance (ii) are photo-oriented. Initially, the molecules of substance (i), i.e. the liquid crystal prepolymers, must not cross-link. However, once they have adopted the preferred orientation, and there is an adequate proportion of substance (ii) photo-oriented for this eventually to occur spontaneously, the molecules of substance (i) may be polymerised or cross-linked with (polarised or non-polarised) light in the anaerobic conditions (e.g. by purging oxygen with a flow of nitrogen or by vacuum). The differential polymerisation of (ii) then (i) may alternatively be achieved by different wavelengths of exciting radiation, though the preferred method remains adjustment of the oxygen partial pressure.

According to the incident angle of the polarised light, a tilt angle can be built in which the liquid crystal molecules will adopt.

Under special conditions, the method may be modified in that the light used for the photo-alignment need not be polarised. If for example the layer is in a cholesteric phase, where the liquid crystal molecules organise themselves in a helical conformation, an alignment of the axes of the helices may be induced by the direction of the incident light.

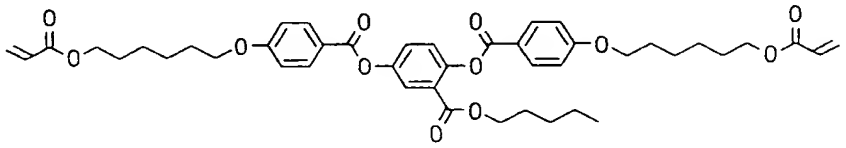
The invention will now be described by way of example.

Example 1

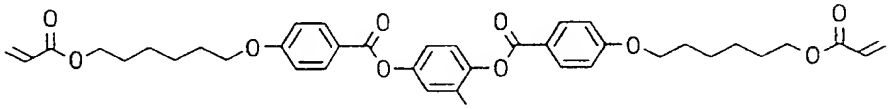
Making a solution of an LPP (linear photopolymerisable polymer)/LCP (liquid crystal polymer) mixture

The following photocrosslinkable substances were used to make the LPP/LCP mixture, of which the LCP components, denoted Mon1, Mon2 and Mon3, are crosslinkable diacrylate monomers:

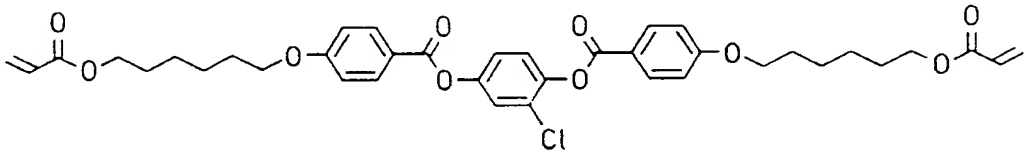
Mon 1:



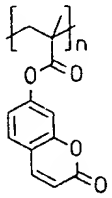
Mon 2:



Mon 3:



LPP A:



LPP A was made as described in PCT Publication WO96/10049 Example 1.

Then an LPP/LCP mixture M1 was made from:

54.4 wt% = 224.0mg of Monomer 1

10.2% = 42.2mg of Monomer 2

3.4% = 14.2mg of Monomer 3

29.2% = 120.2mg of LPP A

1.4% = 5.6mg of a photoinitiator (Irgacure (trade mark) 369 by CIBA), and 1.4% = 5.6mg of BHT (butyl hydroxy toluene) as an inhibitor.

A 5wt% solution of the mixture M1 was made in N-methyl-pyrrolidone (NMP), then stirred for 30 minutes at 50C, and filtered through a 0.2μm filter.

Example 2

Making an Orientation Layer

The solution from Example 1 was thinly spin-coated at 2000 rpm onto two ITO (indium-tin-oxide) coated glass plates, which were then dried for 30 minutes at 130C on a hotplate.

The dried plates were warmed to 75C and irradiated for 6 minutes under ultraviolet polarised light from a 200W mercury high pressure lamp and having an incident angle of 70°. In this procedure, the direction of polarisation of the light lay in the plane perpendicular to the plate and including the incident light direction. The polariser was a film polariser HNP'B by Polaroid. The wavelength of the light was further limited by a uv filter WG295 (Schott) and a bandpass filter UG11 (Schott). The intensity of the uv light at the plate was determined as $2mW/cm^2$.

After this irradiation, the layers were cooled at 1C/min to 65C, then at 5C/min to 50C. The layers were still liquid.

The layers were then irradiated for ten minutes under nitrogen at room temperature by isotropic (not-polarised) light from a mercury lamp at an intensity in the ultraviolet of $4.1mW/cm^2$. Because of the presence of intervening glass (containing the nitrogen), the

incident light no longer included wavelengths below 350nm, which the glass had absorbed.

After this irradiation, the layers were no longer liquid but had become cross-linked.

Example 3

Making a parallel-sided cell

With the coated sides facing inwards, the two plates from Example 2 were assembled into a parallel-sided cell, using a glass fibre of 20μm thickness as a spacer. The cell was immediately filled with a nematic liquid crystal mixture MLC 12000-000 (Merck) at a temperature only just above the liquid crystal-isotropic transition temperature (considered to be 89C in this case), and slowly cooled.

Holding the filled cell between crossed polarisers showed that the liquid crystal mixture was uniformly oriented. Using a tilt compensator and a polarisation microscope, the orientation direction which the coated plates had imposed on the nematic liquid crystal mixture was established to be parallel to the direction of polarisation of the uv light which had irradiated the plates.

The rotating crystal technique showed that the tilt angle adopted by the liquid crystal was a hefty 25°.

Example 4

Making a solution of an LPP (linear photopolymerisable polymer)/LCP (liquid crystal polymer) mixture

Example 1 was repeated, except that a 25wt.% solution of mixture M1 in NMP was used.

Example 5

Coating a Glass Plate

The solution from Example 4 was spin-coated at 1500 rpm onto a glass plate, which was then dried for 10 minutes at 130C on a hotplate. Observation through a polarisation microscope showed that the resulting layer was liquid crystalline but had no preferred orientation. Using a polarising microscope with a hotplate (Mettler FP5) the liquid crystal-isotropic transition temperature was measured as Tc = 69C.

Example 6

Making an optical retarder layer

The layer from Example 5 was warmed to 75C and irradiated for 3 minutes under ultraviolet polarised light from a 200W mercury high pressure lamp. The polariser was a film polariser HNP'B by Polaroid. The wavelength of the light was further limited by a uv filter WG295 (Schott) and a bandpass filter UG11 (Schott). The intensity of the uv light at the plate was determined as $2mW/cm^2$.

After this irradiation, the layer was cooled at 1C/min to 65C, then at 5C/min to 50C. The layer was then removed from the hotplate and placed between crossed polarisers. The layer was now uniformly oriented. On rotating the substrate, it appeared, alternately, wholly dark or wholly light. Touching it established that the layer was still liquid.

The layer was then irradiated for ten minutes under nitrogen at room temperature by isotropic (not-polarised) light from a mercury lamp at an intensity in the ultraviolet of 4.1mW/cm^2. Because of the presence of intervening glass (containing the nitrogen), the incident light no longer included wavelengths below 350nm, which the glass had absorbed.

After this irradiation, the layer was no longer liquid but had become firm and cross-linked. Its thickness was 670nm.

Using a tilt compensator and a polarisation microscope, the layer was found to have an optical retardation of 52.5nm. It was also established that the orientation of the optical axis all over the layer was parallel to the polarisation direction chosen in the first ultraviolet irradiation.

Example 7

Optical retarder layer with tilted optical axis

Example 5 was repeated. Before irradiation, the lower half of the glass plate was covered and the plate rotated 70° about an axis perpendicular to the plane containing the direction of incident light and its direction of polarisation. During irradiation with linearly polarised light, the temperature of the glass plate was held constant at 75C, just as in Example 6. The duration of irradiation was selected to be six minutes, as the effective intensity of the light on the layer was reduced by the rotation of the glass plate.

After this first irradiation, the glass plate was rotated in the opposite direction so that the normal to the substrate surface now made an angle of -70° with the incident direction of the light. Also, now only the upper half of the plate was covered (so that

each half of the plate had only one irradiation). There now followed a second six-minute irradiation, of only the exposed lower half of the plate.

Thereafter, as in Example 6, the coating was slowly cooled and, again as in Example 6, was crosslinked under nitrogen with isotropic ultraviolet light.

On observing the layer through crossed polarisers, a uniform orientation was apparent, leading to alternate lightening and darkening as the layer was rotated. Using a tilt compensator it was established, as in Example 6, that the optical axis was parallel to the plane of polarisation of the linearly polarised ultraviolet light.

The substrate was then so disposed between crossed polarisers that the optical axis made an angle of 45° with the directions of polarisation. On tilting the substrate about an axis which was in the plane of the layer but perpendicular to the optical axis, it could be seen that one half of the layer became darker and the other lighter. Reversing the tilt reversed and inverted the effect.

By obliquely illuminating with linearly polarised light, the molecules of the layer were preferentially orientated at an angle to the substrate surface, whereby the optical axis was established with a tilt with respect to the surface.

CLAIMS:

1. An polymerisable mixture comprising
   (i) a liquid crystal monomer or pre-polymer having cross-linkable groups; and
   (ii) a photo-orientable monomer or oligomer or polymer.

2. A mixture according to Claim 1, wherein the cross-linkable liquid crystal substance (i) is present in an amount of 100 parts, and the photo-orientable substance (ii) is present in an amount of at least 0.1 part.

3. A mixture according to Claim 2, wherein the photo-orientable substance (ii) is present in an amount of at least 1 parts.

4. A mixture according to Claim 2, wherein the photo-orientable substance (ii) is present in an amount of at least 10 part.

5. A mixture according to any of Claims 1 to 4, wherein the photo-orientable substance (ii) comprises molecules showing a cis-trans-isomerism.

6. A mixture according to Claim 5, wherein the photo-orientable substance (ii) comprises azo dyes.

7. A mixture according to any of Claims 1 to 4, wherein the photo-orientable substance (ii) comprises a linearly photo-polymerisable monomer or oligomer or polymer.

8. A mixture according to any one of Claims 1 to 7, wherein the cross-linkable liquid crystal substance (I) has a nematic phase.

9. A mixture according to any of Claims 1 to 7, wherein the cross-linkable liquid crystal substance (i) has a cholesteric phase.

10. A mixture according to any of Claims 1 to 7, wherein the cross-linkable liquid crystal substance (i) has a ferroelectric phase.

11. A mixture according to any preceding claim, wherein the cross-linkable liquid crystal substance (i) is/comprises acrylate or diacrylate.

12. A mixture according to any preceding claim, further comprising chiral molecules.

13. A mixture according to any preceding claim, further comprising dye molecules.

14. A mixture according to any preceding claim, further comprising dichroic molecules.

15. A mixture according to any preceding claim, further comprising fluorescent molecules.

16. A mixture according to any preceding claim, dissolved in a solvent.

17. A presensitised film precursor, comprising a substrate carrying a layer of a mixture according to any of Claims 1 to 16.

18. A substrate having an electrically conductive surface which carries a layer of a mixture according to any of Claims 1 to 16.

19. An optical component comprising an at least partly polymerised layer of a mixture according to any of Claims 1 to 16.

20. An optical component according to Claim 19, wherein the layer is optically anisotropic.

21. An optical component according to Claim 19 or 20, wherein the layer is polymerised with a preferred orientation direction.

22. An optical component according to Claim 21, wherein the layer is polymerised with locally varying preferred orientation directions.

23. An optical component according to any of Claims 19 to 22, wherein the layer has the function of an orientation layer.

24. An optical component according to any of Claims 19 to 22, wherein the layer has the function of a retarder or an optical filter or a polarizer or a polarised light emitter.

25. An optical component according to any of Claims 19 to 22, wherein the layer has the function of an orientation layer as well as a retarder or an optical filter or a polarizer, or a polarised light emitter.

26. A method of making an at least partly polymerised, optically anisotropic layer of a mixture according to any of Claims 1 to 16, comprising

(a) exposing the mixture to linearly polarised light while maintaining such conditions that the polymerisation or cross-linking of substance (i) is essentially inhibited, whereby at least some of the molecules of the substance (ii) are photo-oriented; and

(b) allowing substance (i) to adopt the imposed orientation(s) and exposing the mixture to light, whereby at least some of the molecules of the substance (i) are polymerised or cross-linked.

27. A method according to Claim 26, wherein during step (a) the mixture is maintained in its isotropic phase.

28. A method according to Claim 26 or 27, wherein during step (a) the mixture is exposed to light of different directions of polarisation in different parts.

29. An optical component made by a method according to any of Claims 26 to 28.

INTERNATIONAL SEARCH REPORT

Int. ional Application No
PCT/IB 99/01001

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G02F1/1337 C09K19/38 G02F1/1335

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G02F C09K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	EP 0 445 629 A (HERCULES INC.) 11 September 1991 see page 2, line 18 - line 43 see page 3, line 29 - line 51 see page 6, line 11 - line 55 see page 7, line 45 - page 8, line 16 see page 12, line 3 - line 21 --- -/--	1,2,6,8, 11,13, 14,17, 18,22,26

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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